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ABSTRACT This paper compares changing patterns of science news over a period of 50 years. The study analyses a biannual corpus of 2800 news articles in Britain (the *Daily Telegraph*) and 5800 in Bulgaria (*Rabotnichesko Delo*), and shows divergent and convergent trends. Britain carries considerably more science news than Bulgaria all through the period, while the coverage shows parallel swings: increasing intensity during the 1950s, a turning point in the early 1960s, declining into the 1970s, and rising again in the 1980s and 1990s. Media coverage in both countries shows similar swings in public appeal. The trends in the medicalization of science news, the reporting of controversy and the evaluation of science diverge in the two contexts. The paper concludes with speculative explanations of these results. Similarities and differences in these long-term trends point to common factors and specific differences at work on either side of the (former) 'Iron Curtain'.

Keywords Britain, Bulgaria, longitudinal content analysis, public representation of science, science in the mass media

Long-Term Trends in the Public Representation of Science Across the 'Iron Curtain': 1946–1995

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This paper compares the representation of science in the mass media in two socio-political contexts: modern democratic Britain and modern totalitarian Bulgaria. Our objectives are modest. First, we document the intensity and the framing of science news over a 50-year period, with the aim of describing long-term patterns and trends of reportage in the two contexts. A full historical account of either context goes beyond our present ambition. Second, by documenting our methodology, we encourage colleagues to conduct studies of similar scope and to contribute to a growing database on the 'long waves' of science news. Only by comparing contexts will we be able to explain the changing patterns of representing science in public. Third, the issue 'science in the media' needs robust longitudinal data. The press, radio, television, and recently the World Wide Web, are arenas of public controversy. Claims about the intensity and framing of science news proliferate with little consideration for evidence. Robust data will make a difference in this highly polemical field. Finally,

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and importantly, the changing public drama of science indicates the shifting position of science in culture.

Mass Media Coverage of Science as Culture

Science in the Mass Media: longitudinal, comparative, catholic

Numerous studies investigate the coverage of science in the mass media (for reviews, see: Doran, 1990; Lewenstein, 1995). These studies vary on several dimensions: monothematic or catholic with respect to the sciences, single context or comparative in focus, contemporaneous or longitudinal in scope. Monothematic studies are innumerable, because they fit the scope of student projects and the cycle of problem-orientated funding, while only a handful cover science catholically and longitudinally. With the exception of some studies on the 19th century or earlier, the catholic longitudinal studies are LaFollette's (1990) illuminating study of US family magazines between 1915 and 1955; Kepplinger's (1989) controversial analysis of science news in the political pages of German newspapers between 1965 and 1985; and Nelkin's (1987) somewhat anecdotal, but poignant account of trends in US science reporting of the 1980s. Our investigation is comparative of Britain and Bulgaria, longitudinal from 1946 to 1995, and catholic with regard to the sciences.

The Public Arenas of Science

A study of science in the press contributes to an analysis of the public sphere. The notion of a 'public sphere', a key notion in modern political philosophy, refers to spaces where the political process is staged, gains or loses its legitimacy, and receives inputs. These spaces are both empirical and utopian (Habermas, 1989 [1962]). Some of us have developed a heuristic model to research the public sphere of science and technology (see Bauer, 2002a; Bauer & Gaskell, 2002). Science faces three public arenas with epistemic autonomy: the structures of government, the mass media and everyday conversations. Scientific activities are sometimes centre stage, but mostly not. These arenas work with limited capacity. Topics and actors compete for attention and inclusion, are elaborated according to eigen-logic, and go through a cycle of saturation (Hilgartner & Bosk, 1988). For example, the media arena selects and frames: science makes the news if it is seen as novel, controversial, exciting, with images, locally relevant, personalized, and with a human touch (Neidhardt, 1993; Hansen, 1994). Equally, governments and parliaments selectively change policies and regulations according to power considerations, and members of the public selectively converse and elaborate their perceptions according to everyday interests. Interactions between arenas modulate the attention to a particular topic. So, for example, public opinion emerges from the resonance of conversations with mass media coverage. Science and the public are usefully distinguished: public arenas ignore, hinder, and support scientific and technological developments. Public representations mediate between arenas and are increasingly the focus of professional activities, such as public relations to influence the mass media and perceptions, and lobbying to influence law and policy. Our heuristic highlights inter-connected arenas and thus avoids reducing the public sphere to any one of them.[1]

The analysis of mass media contents is complicated by their double nature as *instruments* of influence and *expressions* of public opinion. What we read as news is part of public opinion, providing input and output of conversations and perceptions. Media analysis makes two contributions. First, it shows what many actors read as 'public opinion'. Politicians, journalists, business people, administrators and scientists read newspapers to keep abreast of public opinion. Media contents thus show 'public opinion as presented and perceived', while the individual reader might ignore, agree or disagree. Retrospectively, we look over the shoulders of past actors and see how 'science in society' might have appeared at the time. Second, the mass media circulate images and arguments and set the agenda: they do not tell us how to think, but what to think about (Cohen, 1963). Or, in the long run, they might cultivate a particular view of an issue (for example, on genetic engineering and biotechnology, see Bauer, 2002b or Bauer, 2005). The mass media are at times an early indicator of public concerns to come. Thus, science coverage in the media exposes *cultural trends* that indicate the changing position of science in society. And these trends are both target and context of politics and business (Bauer, 2000b).

Salience and Framing: Dramatic Devices

To analyse science coverage we use the idea of a dramatic narrative (Burke, 1945). A news article presents to the reader a short drama of science and technology. This idea has several implications. First, it avoids the expectation that science reportage is a faithful mirror of scientific activities and knowledge, and therefore to be judged by its 'accuracy' with reference to 'real science'. Drama suggests a performance in which criteria other than correspondence truth-value apply. Representations of science are not to be judged primarily by their accuracy, but by their rhetorical and aesthetic functions of revealing, appealing and elaborating credibly upon selected events in a public sphere. This mirror is neither plain nor plane. Representations of science circulate in and for the public sphere. They are not epiphenomena, nor just fictional or educational. Their functions vary, but primarily they modulate and synchronize public attention, contribute topics to everyday conversations, and provide orientation and meaning (Bauer & Gaskell, 1999). Second, the notion of drama suggests categories such as stage setting and plot. The plot involves events, actors, conflicts and a moral. Hence, we consider two main dimensions of science coverage. *Salience* of a topic is indicated by the intensity of coverage. It sets the stage and manages attention. We compare the annual fluctuations of science news. *Framing*, including plot and dramatic devices, is a key notion of mass media analysis. It refers to the way a story is told by unfolding arguments, using metaphors and imagery that define a problem, arriving at causal or moral attributions, and prescribing particular remedies (Entman, 1993). A frame often crystallizes in a metaphor or picture, and an actor-sponsor's public position may be enhanced by that frame (Gamson & Modigliani, 1989). Multi-level analysis of framing in the mass media (Scheufele, 1999) is analogous to the analysis of anchoring and objectification in 'social representation' research (Moscovici, 1976; Bauer & Gaskell, 1999). Representation provides a problem definition that is already familiar and therefore makes sense. The question 'how are the media framing science?' becomes a descriptive task following either of two routes: a priori classification (for example, Gamson & Modigliani, 1989; Bauer & Gaskell, 2002) or a posteriori derivation of frames from the *clustering of dramatic devices*. We consider here four dramatic devices of science news: topics, controversy, evaluation and mobilization of the reader. We compare the frequency of these elements over time to characterize the changing public drama of science in Britain and Bulgaria.[2]

Methodology of the Study

Our procedures follow classical routes of content analysis (Holsti, 1969; Krippendorff, 1980), albeit with a constructionist twist (Bauer, 2000a). Our data corpus comprises a systematic selection of newspaper articles on science and technology published in Britain and Bulgaria between January 1946 and December 1995.

Why Compare Britain and Bulgaria?

The comparison between Britain and Bulgaria is partly opportunistic, partly strategic. The Soros Foundation in Prague offered funding to conduct comparative research.[3] During the discussions in our team, we recognized interesting parallels in post-war history. Britain enjoyed a 'special relationship' with the USA based on their nuclear capability, which closely tied the science policies in the two nations (Reynolds, 1988–89; Baylis, 1997). Britain is sometimes described as the '52nd State of the USA'. Since the 1950s, Bulgaria followed Soviet leadership more obediently than any other country in the former Eastern Bloc, and was often called the '16th state of the USSR'. This also bound together their science and technology policies closely (see Crampton, 1997). Furthermore, both societies, in their own way, underwent fundamental transitions during the 1980s, leaving the last vestiges of World War II behind. In the late 1980s, after a decade of economic stagnation and decline, Bulgaria initiated a post-communist transition towards a pluralist democracy that created an uncertain future for science and learning. In Britain, the 'Thatcher revolution' toppled the post-war political consensus. Science and technology entered the remit of public accountability and lost much of their autonomy: science was too important to be left to the scientists (see Dasgupta & David, 1994; Sampson, 2004).

Newspapers, Readership and News Space

For our analysis we chose a key national newspaper: the *Daily Telegraph* (1946–92) in Britain and *Rabotnichesko Delo/Duma* (1946–95) in Bulgaria. Both papers represent the dominant political milieu over the period. The British study is part of a larger research project on science and technology in the press (Bauer et al., 1995; Bauer, 1998b).

The *Daily Telegraph*. British national daily newspapers are segmented into 'quality' and popular press. This duality established itself through the post-war period. The *Daily Telegraph* is one among several quality newspapers, founded in the mid-19th century as a populist alternative to the then elitist London *Times*; a national institution with a consistently conservative outlook, undisturbed by ownership changes (Tunstall, 1987, 1996). Its circulation is the largest among the quality papers. In 1945 the *Telegraph* sold 883,000 copies daily, rising to 1,433,000 in 1980, and declining to 1 million in the 1990s. Its readership is estimated at about three times the circulation, or about 3 million to 4 million readers (Seymore-Ure, 1994). The British are a newspaper-reading public with choice in a very competitive market. In a post-war population of more than 50 million, about 15 million national newspapers are bought every day – this has remained a fairly stable figure despite the advent of television. The *Telegraph* reaches on average about 10% of newspaper buyers and is read in 15–20% of British households. Its core readership is the traditional 'middle England', an increasingly smaller and older market segment, typified by retired army officers with memories of war and empire. For most of the post-war period, in which the Conservative Party was in government, the loyal '*Torygraph*'[4] was the expression of British popular conservatism.[5] As the contents of Conservative ideology shifted, we do not expect to find any consistent bias for or against science and technology. On the contrary, the *Telegraph* prides itself on pioneering quality science reporting.

Until wartime paper rationing was lifted in 1955, newspapers printed five to ten pages. This increased to 25 pages by 1962. In 1992 the *Telegraph* offered 40 pages per day. As print space increased fourfold, advertising space doubled from 30% in the late 1940s to 60% of the print space in the 1990s (Seymore-Ure, 1994: 132). Discounting print space by advertising, the effective news space tripled over the period. We consider effective news space when measuring the salience of science in the public sphere.[6]

Rabotnichesko Delo/Duma. The main Bulgarian newspaper published without interruption during the period 1946–95 is *Rabotnichesko Delo*, the official paper of the Communist Party. After 1991 the Communist Party became the Bulgarian Socialist Party, and *Rabotnichesko Delo* changed its name to *Duma*. Until 1991, *Rabotnichesko Delo* was the official voice of the Party, and therefore of the Bulgarian government. Its daily circulation increased from 150,000 in 1944 to 620,000 in 1969. Later the circulation reached 800,000 copies (Spasova & Ivanchev, 1975). In a population reaching 8 million, this corresponds to 30–50% of households taking a copy. In a competitive newspaper market the circulation of *Duma* collapsed to 35,000 in 1997. The *Delo* was always a thin paper. In the 1940s it printed an average of five pages per day, increasing to eight in the 1980s. *Duma* printed 12 pages on average. Little or no advertising displaced news space until 1991. A monopoly newspaper tolerates no alternative voices to resonate public opinion. The reader, confronted with a monopoly of information, had a choice of three basic attitudes: ignore it; read it to believe its content; or ironically, to read it as a clue to the contrary of what was written.

These two newspapers are functionally similar, but very different sources. They express the views of the dominant ideological milieu: in Bulgaria, the Marxist-Leninist Party, in government from 1947 to 1990; in Britain, the milieu supportive of the dominant Conservative Party in government for most of the period. There was a press monopoly in Bulgaria, while in Britain competition for public attention was fierce. In Britain, about 20% of households may have seen the *Telegraph* at any given time during the period covered (though the overall readership was declining). In Bulgaria, the *Delo* had much larger penetration, but readers faced an information monopoly rather than specifically chose to select the paper.

Sampling of 'Science News'

We define 'science news' in a catholic manner, to include all articles that make reference to scientific activities and knowledge. For methodological purposes, we do not distinguish between science or technology news, or between natural and social science subject matter. The unit of analysis is the newspaper article, whether written by specialists, general journalists or anyone else. By 'reference to' we mean mention of scientific and technological activities, presentation of scientific results, figures, experiments, procedures or equipment (see Bauer et al., 1995).

For the *Telegraph*, we estimated in excess of 150,000 articles that refer to science and technology over the period. Sampling is the only viable way to handle this amount of material. Our unit of sampling is the news article; multiple references to science and technology are counted only once. We defined a probability cluster sample, stratified by year. For every second year in the period from 1946 through 1992 we generated ten random dates, Mondays to Saturdays, excluding the Sunday editions. For each selected issue (the cluster), all relevant articles were identified, copies were made from the British Library's collection, and then coded and stored in the Media Monitor Archive at the Science Museum in London.[7] A total of 2832 *Telegraph* articles were selected and coded.

Because of the smaller size of *Delo*, we were able to consider every single issue. The Bulgarian study comprises all relevant articles over the period. We identified and coded 5841 articles from the 1946–95 period.[8] The newspapers were collected from the National Library in Sofia and coded on-site. Table 1 (see Appendix) compares the two databases, and represents the total intensity of science coverage in Bulgaria and Britain over the period.

The Coding of the Science Coverage: Ensuring Robust Data

Each article is coded manually (see Table 2 in the Appendix). The 10 variables reported here are only a part of a larger coding frame (Bauer et al., 1995; Petkova et al., 1997). The coders, three in Bulgaria and ten in Britain, read articles and record their interpretative decisions on coding sheets that enter an SPSS computer file. Key to the credibility of any content analysis is the inter-subjectivity that can be reached on these interpretative decisions measured by the agreement among coders. The coding frame serves as a guide and as an objectification of this process.

The codes 'country' and 'year' provide basic information. They allow us to compare the salience and dramatic elements of science across context and time. The total number of pages in the newspaper is used to weight the science coverage against the total editorial space. The codes 'big topic' and 'scientific event' characterize scientific events and activities. 'Big topic' identifies 'big science' issues, such as nuclear power, computing and information technology, genetic engineering and biotechnology, environment, space exploration, war on cancer, AIDS and so forth. To code a 'scientific event' we used the classification of disciplines in *Encyclopaedia Britannica* (1992 edition). Disciplines were grouped for analytic purposes into three categories: social, physical and biomedical sciences. This is clearly a difficult part of our analysis. Classifications are not time-fixed entities; the categories may change their boundaries. Events classified as 'physical sciences' in the 1950s may count, only in hindsight, as 'biomedical sciences' and vice versa. In the absence of any standardization, this problem can only be solved partially and with anachronistic hindsight. However, manual coding provides flexibility and makes room for emerging meaning and a 'hermeneutic circle': the more materials coders read, the more the coders understand; and the more their interpretations are grounded in comparisons between articles. 'Controversy' identifies whether a scientific or technological controversy is mentioned, and whether the reporting is done in a non-partisan or a partisan manner. The codes 'evaluation tone', 'consequences' and 'enthusiasm' assess the overall style or tone of reportage, for example, when evaluating risks and benefits of science and technology. Finally, the code 'mobilization' captures the take-home message: for example, whether the reader is called upon to act for or against science or technology. With these few codes, operationally defining dramatic features of reportage, we compare patterns in the use of these literary devices in science news in Bulgaria and Britain throughout the post-war period.

Every research faces issues of data quality. Content analysis poses two reliability problems: selection and coding. Newspaper articles need to be correctly identified as 'science articles'. In the British study, the agreement among selectors varied from .45 to .89 (using coefficient kappa; see Bauer et al., 1995). In Bulgaria, a re-selection of five randomly chosen years reproduced 93% of the sample.[9] The reliability of coding was enhanced by extensive team discussions. This and a pilot study using the coding frame helped to foster common understanding among coders of the coding process and the materials. The British study closed earlier, so the Bulgarian team followed British coding practice. Clearly, some of the materials were more ambiguous than others. We assessed reliability within each team. In the British study, coder agreement ranged from 50 to 80% depending on the code (see Bauer et al., 1995). The Bulgarian team profited from earlier clarification of the coding rules. In Bulgaria coder agreement varied between 81 and 92% (Petkova et al., 1997). Considering sampling procedures, we note that the British data include sampling and measurement error, the Bulgarian data only measurement error.

Reporting the Results

We report our results in the form of 14 propositions (P1 to P14). Besides reporting basic relative frequencies (%) of coding categories, we define several indices that allow us to highlight particular features and to standardize the comparisons. The first index compares annual frequencies relative to the maximum year (= 100). This gives values between 0 and 100 for the intensity of coverage. The second index is the relative difference of two categories, for example the annual percentage of 'benefit' minus that of 'risks'. This gives values between +100 (all article are 'benefit') and –100 (all articles are 'risk'). If benefit articles exceed risk articles in any year, the index is positive (> 0); if risk articles exceed benefit articles, the index is negative (< 0); if equally frequent, the index is zero. Britain and Bulgaria have different variability on these indices. The third index standardizes these annual values to compare the trends across the contexts. We standardize the annual values by setting the mean at 0 and standard deviation at 1 over the entire period. This provides graphics with harmonized variance for Britain and Bulgaria, and helps the reader to focus on the trends. An optimally fitted curve further highlights the trend.

Most values will suggest non-linear trends, which are highlighted by fitting a third order ($y = a + bx + cx^2 + dx^3$) or cubical polynomial. These curves are purely illustrative, using the visual options in EXCEL; they do not document complex modelling. Because testing of non-linear models is cumbersome, we use the linear assumption to report statistical association between variables and time (expressed by parameter *eta*), and the interaction of year and country (expressed by parameter *eta*^{2}). All reported results are statistically significant at $p < .01$ in a two-factor analysis of variance (ANOVA) model of country (1;2), years (1;26) and their interaction. The 'country effect' measures the variance explained by context: Britain and Bulgaria. The 'year effect' measures the variance explained by time. An interaction effect points to divergent trends in the two contexts. All variables show more variance between contexts than over time. This may in part be a team effect of coding, but is not a major problem for our analysis. We mainly analyse trends relative to each context, and do not focus on differences in levels. Our database is rich and the results presented are only a selection. We focus on single variable comparisons. We will leave for future work interesting questions about the clustering of variables and how these might regroup over time when examined through empirical frame analysis, and how this might differ in the two contexts.

The Salience of Science News Over 50 Years

P1: Britain carries substantially more science news than Bulgaria all through the period.
The public salience of science and technology is reflected in the public sphere of a given society. We measure the public salience of science by examining the number of articles published in a leading newspaper. In annual aggregates there is high correlation of issue salience between several newspapers and between newspapers and other mass media outlets. One newspaper is therefore a valid proxy for all the mass media in the long run.[10] On the basis of our sample we estimate between 150,000 and 190,000 articles referring to science in the *Telegraph*, and we count a mere 5841 articles in the *Delo*. Taking into account the different numbers of articles devoted to news in the two papers, we calculate one science reference for every two or three pages in the *Telegraph*, and one reference for every fifteen pages in the *Delo*. Hence, considering a multitude of news sources in Britain and an information monopoly in Bulgaria, science news was substantially more intense in Britain than in Bulgaria.[11] While British readers were exposed to daily science news all through the period, in Bulgaria days would pass without any science news at all.

P2: British and Bulgarian science coverage shows a parallel cycle of intensity.
More revealing than overall intensities are the long-term trends. Figure 1(a) and (b) shows the salience of science, with and without considering news space, and relative to the peak year (1962 in Britain; 1994 in Bulgaria).

In Bulgaria we see smaller fluctuations in salience. The number of articles per year varied between 50 and 100 index points. After low coverage in the years immediately after 1946, coverage rose to a peak in 1960–62, then it declined to the low point 1980, and rising again into the 1990s. A relative boom in science coverage can be observed in the late 1950s, trending high through most of the 1960s, again in the mid-1980s, and then after the changes in the 1990s. The intensity of British science coverage was subject to more dramatic shifts: varying between 30 and 100 index points, with a sharp increase until the peak of 1962, a decrease into the 1970s, and then a marked recovery ever since. The decline in the 1960s briefly stalled in 1970 and 1972, reflecting the reportage of the US moon-landings and the discussions emanating from two public enquiries over the future of British science: the Dainton and the Rothschild reports of 1971 (Dainton, 1971; Rothschild, 1971; Wilkie, 1991).

FIGURE 1

Several features of the intensity of science coverage are revealed by these two figures. First, the overall trend is illustrated by a 'waved' cubical curve. This function takes a parallel shape in both contexts: high into the 1960s, low in the 1970s, rising in the 1980s. In Britain the recent recovery starts in the mid-1970s; in Bulgaria in the early 1980s. This wave remains the same, when we take into account news space as shown in Figure 1(b). A non-linear trend is supported by evidence from two other studies. LaFollette (1990) reports a rise in science coverage into the 1950s in the USA, and Kepplinger (1989) documents the decline in the 1960s and the recovery of science news in the 1970s for Germany. Second, the non-weighted values in Figure 1(a) suggest peak coverage in the early 1960s, and the recovery of that level in the 1990s after the trough of the 1970s. Figure 1(b) shows that this may be an illusion arising from non-weighted counts. The recovery of the science coverage during the 1980s is compensated for by the increasing amount of space devoted to news. The level of effective coverage of the 1960s is not attained by the 1990s, either in Bulgaria or in Britain. With current levels of media enthusiasm about computing, space exploration and genetic engineering, these levels might well have been matched by now.[12] Comparing Figure 1(a) with (b) shows how important it is to use relative measures. Article counts should be weighted by the effective news space to avoid misleading conclusions as to the public salience of science.

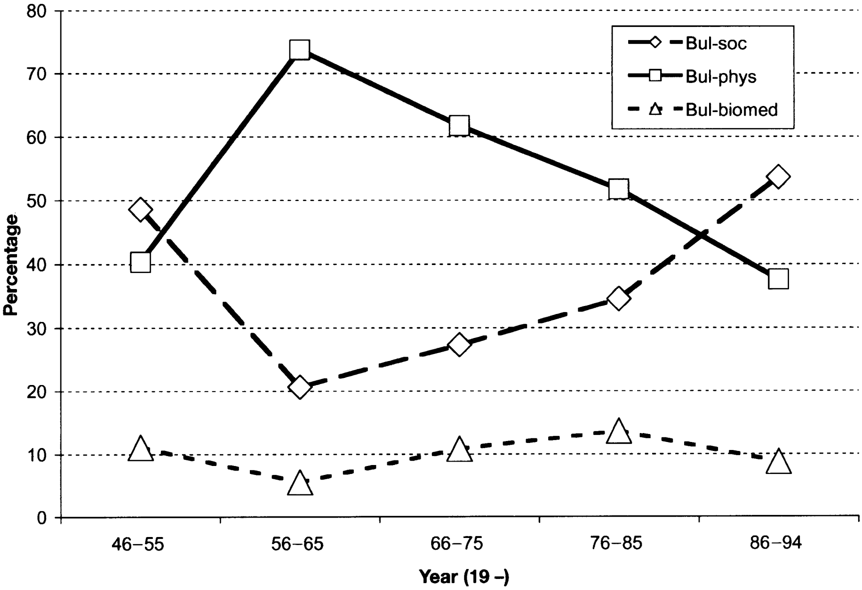
The Public Drama of Science

The mass media operate selectively because of limited space, and thus bring to the fore certain topics and not others. The differential visibility of the sciences is an indicator of what is considered culturally relevant at a particular time. Editorial decisions in a market-controlled press differ from those in a party-controlled press. But the selection of science news reflects the mind-sets of the gate-keepers in either context, and what they think their audience ought or might like to read. In Britain, it shows what was considered to be of interest to mainstream 'middle England', the dominant Tory establishment and conservative readers; in Bulgaria it shows what was thought to propagate Party doctrine of the 'interest of the working people', and to please the current Party hierarchy.

P3: Britain witnesses the 'medicalization' of science, but not Bulgaria.
We coded our data for the different scientific disciplines mentioned in the articles and reduced them to three basic groups: the social sciences (history, philosophy, sociology, psychology, literature and so on), the physical sciences (physics, chemistry, astronomy, geology, engineering and so on) and the biomedical sciences (biology, medicine, agronomy and so on). We defined five periods roughly corresponding to the phases of the waves identified for the overall salience of science. Figures 2 and 3 show the percentages of reportage dedicated to these three basic groups of sciences in each period.

In Bulgaria the social sciences comprised almost 50% of coverage

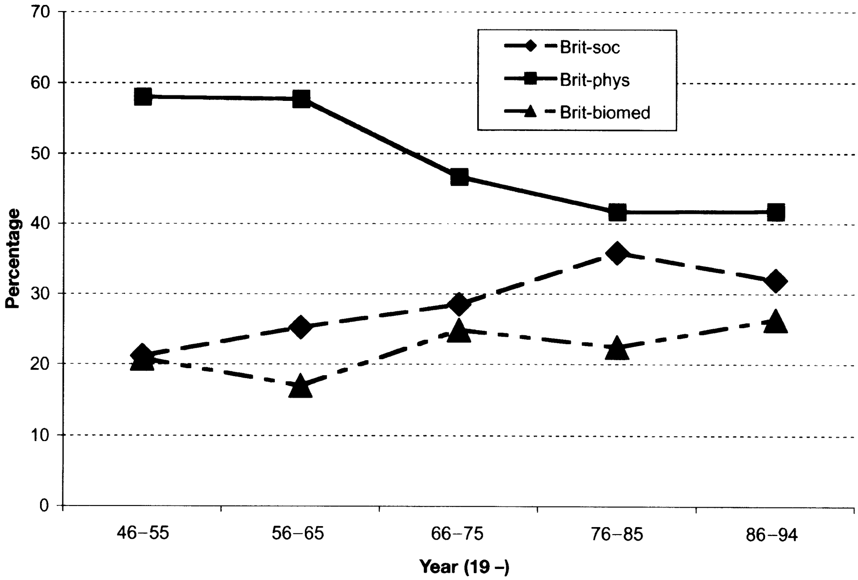
FIGURE 2
The coverage of scientific activities in the Bulgarian press between 1946 and 1995: social sciences, physical sciences and biomedical sciences in percentages of total science coverage in five periods.



immediately after the war, as shown in Figure 2. Their importance is consistent with the ideological discourse of the Communist Party, which had established its dominant position after the war. During the first years of socialist construction, the party devoted great efforts to promote Marxist-Leninist ideology and build an epistemology for disciplines like scientific communism, historical materialism, and party construction. In the three decades that followed, the social sciences dropped sharply, only to increase significantly again after 1986, anticipating and following the revolution of 1989. The interest in the physical sciences doubled from the first to the second period, while decreasing through the following periods. The biomedical disciplines received stable and low coverage of around 10% of all references through all the periods covered in Figure 2. This pattern reflects some specific developments of Bulgarian society. The years after 1956, with a sharp increase in the coverage of the physical sciences, were also the years of rapid modernization of the country, involving industrialization, especially in heavy industry and chemicals. This extensive development exhausted itself in the 1980s, and is perhaps anticipated by the continuous decline in coverage of the physical sciences, and the rising trend in the social sciences. The latter reflects the search for solutions to societal problems and for a new ideological orientation.

Figure 3 shows the changing coverage of the three basic groups of sciences in Britain. Compared with Bulgaria, the social sciences receive less coverage in the first period, when the physical sciences dominated with

FIGURE 3
The coverage of scientific activities in the British press between 1946 and 1992: social sciences, physical sciences and biomedical sciences in percentages of total science coverage in five periods.



58% of all references. In the 1960s, things started to move: the years 1966 to 1975 were marked by a rise in coverage of the biomedical and social-scientific disciplines. In the final period, the coverage of the three groups almost equalized. Science coverage had diversified over the post-war years.[13] An update with data from more recent years shows an emergent dominance of biomedical coverage in Britain. Some of us designate this trend as the 'medicalization of science news'.[14] During the 1990s biotechnology and genetic engineering 'took pole position' among sciences covered in the public sphere, fuelled by national and international controversies over genetically modified crops and foods, DNA testing and therapy, gene patenting, bio-piracy, gene banks and stem cell cloning (Bauer & Gaskell, 2002).

P4: News of nuclear power, once dominant, faded in both contexts; news of computing and the environment is higher in Britain, while space news dominates in Bulgaria.

Another indicator of the changing drama of science is the coverage of large scientific and technological projects, so-called 'big science' programmes. One-third of articles in Bulgaria and one-quarter of articles in Britain are coded as 'big topic' reports. Of these, the most frequent are nuclear power, genetics and biotechnology, computing technology, space exploration, and environmental news including pollution and conservation, and the search for alternative sources of energy. Other topics, such as birth control, 'war on cancer' and HIV/AIDS, are much less prominent, partly because they are more recent or do not feature over the entire period. Overall, 97% of the articles on space, 93% on nuclear power and 86% on computing refer to the physical sciences; 71% of articles on genetic engineering refer to the biomedical sciences; while 32% of the articles on the environment refer to the social sciences. The contexts differ somewhat: articles on nuclear power in Britain more frequently mention social sciences than in Bulgaria, while Bulgarian articles more frequently mention the social sciences in connection with computing and the environment. In Britain the large issues were nuclear power (34%), computing technology (20%) and the environment (16%). In Bulgaria these were space exploration (53%) and nuclear power (19%). Bulgaria had a role in the Soviet Space Programme, and was the only country besides Russia that contributed cosmonauts to the Soviet Space Programme. This had considerable repercussions for popular scientific culture.

The shifting salience of big topics shows similarities and differences. In the 1980s and 1990s nuclear power lost its position after being the primary topic during the 1950s and 1960s. Genetics was not in the news until the 1980s and 1990s. Space exploration was hot news in the late 1950s ('Sputnik' in October 1957) into the 1960s. Environmental news started to appear in the late 1960s and increased during the 1980s. In contrast, computing technology showed two salient periods in British coverage, one between 1966 and 1976 and the other after 1984, with the arrival of personal computing. There has been a third salient period between 1995 and 2001 with the 'internet bubble', but our corpus does not extend to those years. Bulgaria did not show the 1960s peak; coverage increased continuously into the 1980s when Bulgarians became known for a competence in software engineering within the COMECON division of labour. In Britain, the period 1954–62 was the time of nuclear power: the establishment of military (1952) and civilian ('Calder Hall' at Windscale, 1956) nuclear capabilities. The period, 1962–70 witnessed the 'moon race' between the USA and USSR, culminating in the live images of the moon-landing of 1969 and Neil Armstrong's radio message to the world: 'a small step for a man, a giant step for mankind'. The late 1970s and early 1980s put nuclear power again into public focus, this time in connection with mounting national and international anti-nuclear protest. The same period saw and celebrated the arrival of home and personal computing and, with apprehension, anticipated '1984'. Orwell's ominous year stood for the totalitarian potential of information technology. Since the mid 1980s, Britain entered an era of public awareness of biotechnology, hailed as the new technology of the 21st century, replacing the merry-go-round model of the atom by the double-helix model of the gene as the iconic core of the public imagination of a technological future.

Evaluating Science

Another aspect of the framing of science is the evaluation it receives in the mass media. We consider three indicators: the apparent tone of evaluation, the enthusiastic pathos of the copy and the utilitarianism of risk–benefit arguments.

P5: In Bulgaria the evaluation of science becomes more negative; in Britain it oscillates.

A useful indicator is the 'evaluation tone'. Coders rate each article asking the question: does the reportage offer a discourse of great promise, a rating of 1, or does it offer a discourse of great concern, rating of 5, or something in between? With large numbers of observations, such ratings give a reliable indicator of the changing public image of science, but without further clarifying the discursive elements that constitute promise or concern.

Bulgarian coverage of science and technology is generally more positive than that of the British media. In Bulgaria, science is loaded with great expectations, as the prime factor of societal progress. Only 12% of the materials in *Delo* stipulate concern over scientific developments, compared with 48% in the *Telegraph*; conversely, 57% of the articles in *Delo* hail the promises of science whereas the *Telegraph* does so 27% of the time. An entirely promising image of science in Bulgaria and a more sceptical one in Britain do not come as a total surprise. Marxist scientism with its promise of a golden future was official doctrine in Bulgaria. The *Telegraph* is ultimately a conservative paper, in which a residual anti-modernism may have survived the post-war modernism of science and technology. Overall, the coverage is most positive for the physical sciences, less so for the biomedical sciences and least for the social sciences.

Figure 4 shows different trajectories for the evaluation of science and technology in the two national contexts. The trend in the Bulgarian press is linear and leads away from a predominantly positive discourse of 'great promise'. The year-to-year fluctuations are rather small. Significant changes occurred in the early 1980s. At that time an emerging public sphere allowed questioning of the dogma of the progressive role of science in society. This questioning reached its peak in the early 1990s, only to reverse again in 1994, perhaps reflecting changes in the social position of science. Bulgarian scientific institutions operated under Marxist ideology. The Communist Party provided privileges and shielded scientists from critical public commentary, and from analyses of unintended consequences of developments. The change in tone during the 1980s was a result, on one hand, of failed party directives and, on the other, of the influence of Soviet-inspired 'glasnost' and 'perestroika'. These openings created an emerging public sphere together with more open discussion of science and technology.

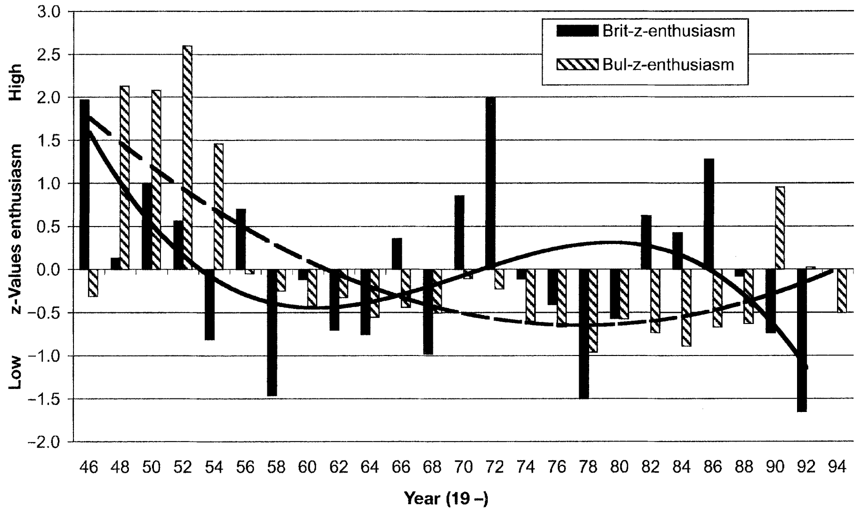
Britain presents a rather different picture. Evaluation does not follow a linear trend. In pendular fashion, the evaluation of science swings between more positive or more negative coverage. The reportage started with a concerned tone in the aftermath of World War II, possibly echoing the shock of the nuclear age initiated by the bombs of Hiroshima and Nagasaki in August 1945, as well as economists' discussion over how to rebuild the economy with or without US capital. Coverage then swung to a more

FIGURE 4
The evaluation of science in the Bulgarian and British press between 1946 and 1995. The values are average annual values standardized in each context. High values indicate positive reportage above long-term average; low values indicate more negative reportage. A third-order polynomial is best fit for Britain, a straight line for Bulgaria.

positive discourse from the second half of the 1950s through the early 1960s, perhaps reflecting the optimistic modernism that culminated in the expectations of the 'white heat of technology'. In October 1963, Harold Wilson told the Party Conference: 'We are redefining and we are restating our socialism in terms of the scientific revolution ... the Britain that is going to be forged in the white heat of this revolution ...' (see Wilkie, 1991: 73ff.). In the following year Wilson became Labour Prime Minister.

The pendulum turned more negative later in the 1960s and through the 1970s, only to swing back to celebratory coverage during the Thatcher years of the 1980s. The years 1972 and 1976 broke the trend with positive reporting. In 1985 The Royal Society of London published its nationally and internationally influential report, 'Public Understanding of Science' (Royal Society, 1985). In that report, the various strands of the mass media were admonished to produce more stories and to write more engagingly about science and technology. Our data demonstrate that, by that time, the British press had already altered its rhetoric. The Royal Society came to reinforce an existing trend in the 'Zeitgeist'. The report instilled new life in the traditional sectors of the public understanding of science movement by stimulating a range of activities in Britain. Among these was a public understanding of science research programme bemoaning, analysing and deconstructing the supposed 'public deficit' in scientific literacy and attitude (for a critique of the 'deficit model', see Irwin & Wynne, 1996).

FIGURE 5
The enthusiastic pathos for science in the Bulgarian and the British press between 1946 and 1995. Enthusiasm is the sum of two scores on semantic differentials: pessimism–optimism and criticizing–advocating. The values are annual averages standardized for each context. High values indicate enthusiastic reportage above average, low values mean below average enthusiastic reportage. The fitted curves are third-order polynomials, the thick line for Britain, the dashed one for Bulgaria.

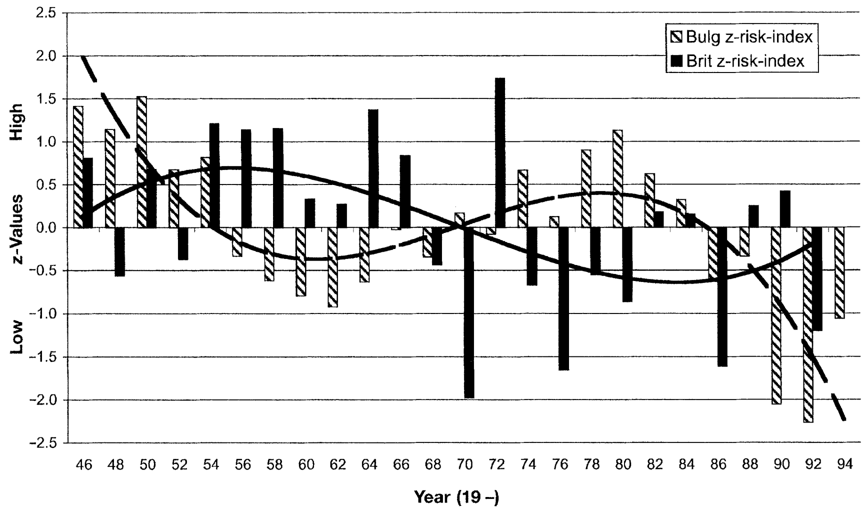


P6: The pathos of science writing follows a different rhythm in Britain and Bulgaria.

Additional information about media treatment of science and technology can be inferred from the pathos of the writing styles. We use semantic differentials (Osgood et al., 1957) to characterize the 'appeal' element in the rhetoric of science reportage. We construct an *enthusiasm index* from ratings of 'optimism' and 'advocacy'. Overall, reportage on science, consistent with an emphasis on promise, is more celebratory than inquisitive in both nations. The trajectories of enthusiasm are shown in Figure 5. In Bulgaria enthusiastic reporting is highest in the post-war years, calms down in the middle period, and gains strength again in the 1990s. Overall the writing shows relatively little variation in 'enthusiasm'. In Britain we find again a swinging pendulum, with large fluctuations: enthusiastic in the early years after the war and less so during the 1960s; high in the early 1970s, low in the late 1970s, high in the mid 1980s and low again towards the 1990s.

Comparing enthusiasm with the evaluation of science (see Figure 4) shows a counter-cyclical trend for Britain. Enthusiasm, meaning optimistic and partisan pathos, may serve a defensive function in public controversies over science and technology. Whenever enthusiasm grows stronger, science coverage tends at the same time towards a discourse of concern. However, enthusiastic style is less marked when science writing already stresses the promise of science and technology, as is the case in the late 1950s and early

FIGURE 6
The risk/benefit, utilitarian evaluation of science in the Bulgarian and the British press between 1946 and 1995. The values are annual averages standardized in each context. High values indicate more benefit news, low values indicate more risk news than usual. The fitted curves are third-order polynomials, the thick line for Britain, the dashed one for Bulgaria.



1960s. The later correlation of negative evaluation and lack of enthusiasm – in other words the disappearance of the compensatory mix of articles with negative evaluation besides articles with enthusiastic voice and vice-versa – may be an *early indicator* of what later officially became known as the 'crisis of confidence' in science within British and European discourse (House of Lords, 2000).

P7: Risk reportage is on the increase, but varies in a counter-cycle in Britain and Bulgaria.
The risks associated with scientific developments have become incorporated into the public image of science, leading to assessments of science and technology by reference to its consequences in a utilitarian framework. Our analysis of each article asks whether it refers to risk and/or benefit. Overall, benefit references exceed risk references in both national contexts.

We define a *benefit/risk index* as shown in Figure 6: high values show that benefits exceed risks above the long-term average, therefore indicating relatively beneficial reportage; low values indicate that risk references are more than usually frequent in the reportage, but not necessarily exceeding benefit stories. In Britain, we find high benefit in the 1960s, lower benefit and more risk in the 1970s and 1980s, and higher benefit again into the 1990s. The exceptional years in terms of media risk/benefit assessment are 1970 with the least favourable, and 1972 with the most favourable public assessment of science. These years correspond with controversial discussions over the future constitution of science in Britain, culminating in the two contradictory reports – one by Lord Rothschild on science as a private good and the other by Lord Dainton on science as a public good. In this context of rising public sensitivity to risk, science was unable to sustain its privileged position in relation to other societal activities. Science, like other societal activities, was required to secure society's trust and confidence by accommodating public concerns and fears. Science increasingly became publicly accountable, asked to prove that scientific progress is beneficial for social development. In Bulgaria we find a smooth trend from high benefit in the post-war years, to lower benefit in the 1960s, to again towards more benefits into the early 1980s, and the emergence of risk coverage in the 1990s. All things considered, we witness here a convergence in the representation of science as a risky business. While fluctuations followed a different phasing, in the long run risk reportage increased towards what came to be known as the 'risk society' in the 1990s (Beck, 1991).

During socialist development in Bulgaria, science was almost never questioned. Until 1985, the percentage of articles that mentioned risks associated with scientific developments was very low. Between 1946 and 1955 it stayed level at about 10%. At that time, 'risk reportage' was attributed to 'bourgeois genetics' and the inevitable failures of capitalism to mobilize atomic energy for the greater good of humanity (see Rubinstein, 1954). In subsequent years, praise of science and its importance for socialist construction became party policy. Consequently, questioning attitudes towards science became even scarcer: between 1956 and 1984 an average of 5% of reportage contained references to negative consequences. The most recent period, however, has been more attuned to negative consequences. Risk reportage increased to 40% of the articles in the 1990s. The picture in Britain is rather different. The proportion of risk references is much higher in Britain than it is in Bulgaria all through the period. During the 50 years of science coverage, more than 40% of the reportage refers to risks of scientific developments. In several years the risk reportage exceeds 50% of the reportage: in 1950, 1968, 1972, 1978, 1982, 1986 and 1988. Risk reportage is more salient in later years; the turning point in the long-term trend was mid-1960.

P8: In Britain enthusiastic reporting co-varies with risk reportage, but not in Bulgaria.

Overall, articles that evaluate science negatively also are likely to refer to risks and unlikely to refer to benefits of science. Enthusiastic stories are unlikely to refer to risks, and only somewhat likely to benefits. Such stories however are highly likely to exhibit discourse of great promise.[15]

More revealing is the annual mix of articles varying on these dimensions. In years when science is evaluated more positively, we also find more articles referring to benefits of science. However, this is more likely to be the case in Bulgaria than in Britain. In years when the writing is enthusiastic we also read more about the benefits than about the risks of science, but the correlation is low. This suggests that enthusiasm for science may deploy alternatives to utilitarian risk/benefit arguments. Furthermore, in years with more negative evaluation of science, we find less enthusiastic writing in Bulgaria. However, in Britain in such years enthusiastic writing is higher. More negative articles tend to coincide with more enthusiastic writing. In Britain, this is particularly the case in the early 1970s. This may indicate a debate in which either: (1) concerns about science counteract exuberant enthusiasm; or (2) enthusiasm reacts to prevailing negativism. A defensive function of the enthusiastic pathos for science, as mentioned earlier, would indicate the latter. In Bulgaria this correlation of negative with enthusiastic reportage comes into play only after the changes of 1990, while in Britain it disappears over time.

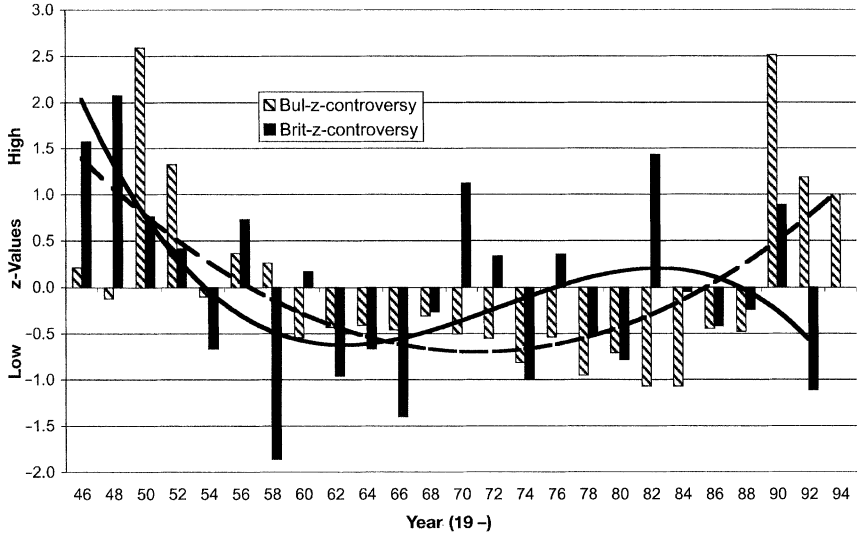
Reportage of Controversy

We recorded whether or not articles refer to any controversy over science and technology. The results show differences between the Bulgarian and the British coverage.

P9: British reportage is more controversial and more non-partisan than Bulgarian reportage.
Overall, just 7% of the reportage in *Delo* refers to controversies, compared with 22% in the *Telegraph*. In Bulgaria the reporter is more likely to be partisan (87%), while in Britain he or she is more likely to be non-partisan (62%) and to report both sides of the argument without explicitly taking sides. British science reportage makes more reference to controversy, but takes a less partisan stance than its Bulgarian counterpart. This is not surprising, considering the function of the mass media in the different ideological contexts: in Bulgaria *Delo* was an uncontested instrument of Party propaganda, whereas in Britain the *Telegraph* is part of a highly competitive commercial newspaper market serving a public sphere.

P10: Reportage of controversy decreases and then increases after the 1970s in both contexts.
Again the trajectories are revealing: Figure 7 shows our *controversy index.* An index less than zero means below average reportage of controversy, whereas an index greater than zero means above average reportage of controversy. In Bulgaria, controversy is unusually prominent in 1950 and 1952, and also in the 1990s. In the years in between, there is less reportage of controversy. The early period presents the Stalinist polemic against capitalist science and technology and its necessary failure of humanity, in contrast to the functions of socialist science for the building of communism (see Rubinstein, 1954). In Britain, controversy was unusually high in the years immediately following World War II, but then declined to its lowest level in 1958. Since the early 1960s, we observe a trend towards more controversial reportage. Years with exceptionally controversial reportage were 1946, 1948, 1970, 1982 and 1990. Fluctuation is much greater in the British than in the Bulgarian coverage.

FIGURE 7
The degree of controversy in the reportage of science in Bulgaria and Britain between 1946 and 1995. The values are annual averages standardized in each context. High values indicate more controversy reportage, low values mean less controversy reportage than usual. The fitted curves are third-order polynomials, the thick line for Britain, the dashed one for Bulgaria.



In the literature on news values, 'controversy' features prominently: no controversy, no news. This may be an operative rule in news production, but our data do not support it as a fact. Intensity and controversy are not correlated in Bulgaria, and contrary to expectations they are negatively correlated in Britain. Years with intense science coverage feature less controversy (r $-$ 0.41; N 25; p = .05). In Bulgaria there is no relation between controversy and amount of science coverage, while in Britain controversy goes with lower coverage. This suggests that controversy may not be the historical 'driver' for science news, as is often claimed (Neidhardt, 1993; Hansen, 1994).[16]

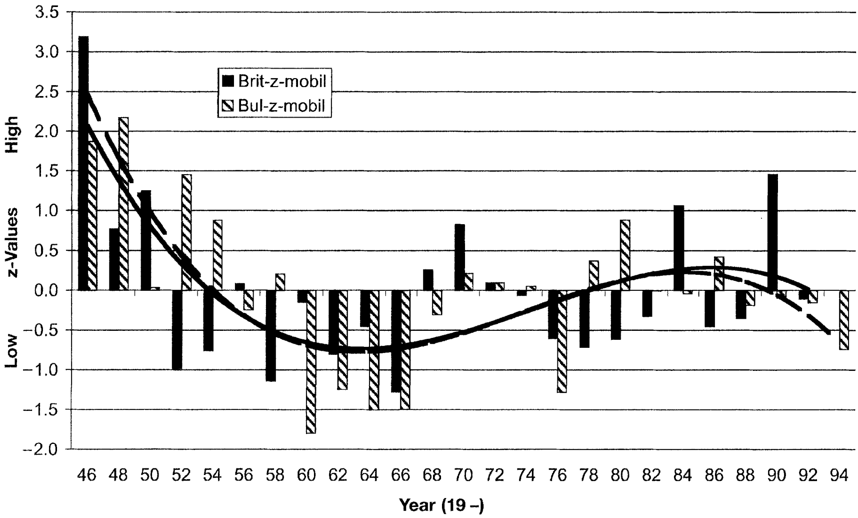
Mobilizing Public Support or Resistance

'And what is the moral of the story?', we ask at the end of a drama, fairy tale or fable. We expect a take-home message also from science reportage. For each article we ask whether there is a call to action addressed to the reader. Our coders decide whether an article attempts to mobilize the reader into an attitude and/or a social action. The reader may be asked to rally in support of or to actively resist a new development.

P11: Mobilization for science is stronger in Bulgaria than in Britain, but follows the same trend.

We found that 64% of the science articles in the Bulgarian press carry such an appeal to action, whereas in Britain the equivalent figure is much lower

FIGURE 8
The public mobilization through science reportage in the Bulgarian and the British press between 1946 and 1995. The vaules are annual averages standardized in each context. High values indicate years with above average mobilization of the reader. The fitted curves are third-order polynomials, the thick line for Britain, the dashed for Bulgaria.



(20%). Figure 8 shows the *mobilization index* standardized for each context. Values greater than zero indicate above average numbers of articles that mobilize the public; values less than zero indicate below average mobilization. Overall, the Bulgarian index is +28, the British equivalent is − 62. In Bulgaria, mobilizing the reader is part and parcel of the reportage of science and technology; in Britain this is the case to a much lesser degree.

Disregarding the large differences in level, the trajectory of mobilization is revealing. Both Britain and Bulgaria show an identical trend: higher than usual mobilization in the 1950s, lower in the 1960s, and increasing calls for public activism since the 1970s. In the latter period, particularly intense years were 1970, 1984 and 1990 for Britain, and 1970–74 and 1980 for Bulgaria. In general, the British press shows a more restrained voice with fewer calls for attitude and action, whereas in Bulgaria mobilization supports the official Party line. In Britain, we also see calls for resistance to developments, reflecting the impact of the anti-nuclear movement developing after the 1950s and more critical discussions of science and technology since the 1970s. In Britain, 1971 is an important year, when different visions of science in society were publicly debated, and support and resistance to science were on the media agenda.

There is some ambiguity in this indicator. 'Calling the reader to action' can refer to different conceptions of the public's role in science and technology. On the one hand, mobilization means to call for public support for and appreciation of new developments. This is very much the theme of celebratory propaganda. On the other hand, mobilization can imply an anti-technocratic vision of 'public participation' in science and technology policy-making. To get actively involved means to claim a voice in the funding and regulation of science and technology. Although we do not distinguish these two notions of mobilization in our coding, it may fair to suggest that anti-technocratic mobilization has gained momentum in the West during the 1970s, and has since become prominent in public debates over science and technology.

Discussion and Conclusions

We described and analysed changing patterns of science news coverage over a period of 50 years. This is the first investigation of its kind: comparative, longitudinal and catholic with regard to the sciences. The results show differences, but also similarities in long-term trends in science reportage across very different contexts. We end with some speculations on these patterns.

P12: Low or high fluctuations reflect the degree of control of the mass media system.
A striking difference between Bulgaria and Britain is the variability of science reportage. All our indicators show higher year-to-year fluctuations in Britain than Bulgaria. This result is consistent with a model of cybernetic control processes over limited print space. The degree of internal control of a system determines its sensitivity to external perturbations and thus the variability of its operations. High control lowers environmental sensitivity and reduces variance; less control increases the reactivity to external events and leads to more operational variance. This model fits the data and suggests, by way of a logic of abduction, that British science coverage was less controlled and more responsive to the world of science and the public sphere. By contrast Bulgarian science reportage was more tightly controlled and less responsive to events.

This hypothesis regarding the general pattern is consistent with conceptions of a democratically open Britain and a totalitarian and closed Bulgaria. In the Bulgarian case, at least until the beginning of the 1990s, press coverage of science depended on the current policies of the ruling Communist Party, and no other social input was tolerated. The Marxist-Leninist model of modernization pushed the role of science to hypertrophy and made it the locomotive of social progress. The Bulgarian Party press circulated overwhelmingly optimistic and celebratory news of science. Science was the unquestioned benefactor of society, indispensable for social progress. This representation was put forward with very little variability in contrast to its British counterpart. In Britain, the post-war modernization process gave science a comparatively more 'modest' societal role, albeit celebrated at times, as in the years leading up towards the 'white heat of technology' of 1963. The British press demonstrated much more variable attitudes towards science. Science was presented in its positive role for social development, but increasingly with the potential for unforeseen and problematic consequences for the environment and for society. This tendency became visible especially in the last quarter of the 20th century. A similar shift in public discourse over science and technology emerged in Bulgaria, but only with the constitution of a public sphere after 1989. The latter observation points towards a late convergence between the two contexts.

P13: Parallel trends, but different factors at work in Britain and Bulgaria.
We found parallel trends in the intensity of science reportage, the degree of mobilization, and the emergence of risk discourse. Disregarding the different levels of these variables in Britain and Bulgaria, it is surprising to find that despite very different political and economic contexts many trends in the coverage of science and technology parallel each other. Our index of intensity suggests two waves with identical phasing: high in the early 1960s, declining into the 1970s, and rising again in the 1980s and 1990s. Over time, the cycles of public attention to science are identical in the East and in the West. This clearly deserves further examination. What were the linkages that breached the 'Iron Curtain' despite the decoupling of the political processes?

P14: Was 1971 an axial year on both sides of the Iron Curtain?
In the East, the decrease in science coverage coincided with periods when the Bulgarian Communist Party was preoccupied with serious party or state problems. These deliberations dominated the press, leaving less room for science news. Thus, the beginning of the 1950s was a period when the power struggles in the Party were being resolved. In the late 1970s and early 1980s, we also see a decrease in interest toward science. These were the years of anticipation and celebration of the 1300th anniversary of Bulgaria, in an orchestrated reassertion of the Bulgarian nation at the expense of the Turkish minority. In contrast, the peaks in coverage followed new Party directives. Here, science coverage played its part in the implementation of Party decisions. Thus, the boom of the late 1950s was the result of the decisions taken by a new Party elite, which came to power in April 1956 with a programme to industrialize the country. The end of this period was marked by uncertainty over the role of science in society. In the early 1960s, Party circles ardently discussed the nature of 'revolution', 'progress' and the development of society in the debate between the physicists and the poets (Crampton, 1997; Yahiel, 1997). The party congresses, such as the July plenum of 1979, the February plenum of 1985 and the January plenum of 1986, which were devoted to science and technology, affected the science coverage. In 1979 *Rabotnichesko Delo* even carried a special science page. After the transformations of 1989, science coverage changed completely. During the first years of the transition (1990–91) interest in science declined sharply. This does not come as a surprise in a situation where everything suddenly becomes public and political. The Communist Party became preoccupied with internal problems, and its newspaper, renamed *Duma*, focused on those problems. After

1992, science coverage increased rapidly, with regular science news, and the social representation of science saw a new beginning.

The early 1970s are candidate years for an axial transition common to both contexts. After the celebration of 'white heat of technology', the space race and heart transplants in the West, and the creation of the 'agro-industrial complex' in the East, a new position of science in society surfaced on either side of the Iron Curtain. In the East, the 24th Party Plenum of the USSR of 1971 declared the '*scientific–technological revolution*' to exploit the 'advantages of socialist science during the final crisis of capitalism' (see Hoffmann & Laird, 1982). This was echoed in Bulgaria in the following years, and mixed with attempts to assert the national culture. In the West and in Britain this is the period when the '*post-war contract*' of science and society – pure science is economically beneficial and best left to the scientists – came under revision, and under a different maxim: science is too important to leave to the scientists. Two contradictory reports on future science policy were published in Britain in 1971. The Rothschild report argued for more market forces and a customer–contractor relationship in the conduct and funding of science. The Dainton report argued that science is a public good and needs public funding (Wilkie, 1991: 78ff.). These events pre-date the 'oil crisis' of 1973, the economic recession of the mid 1970s, and the 'winters of discontent' in Britain that prepared the ground for the Thatcher revolution during the 1980s.

The similarities in the public image of science in Bulgaria and Britain lead us to consider factors that are common to media coverage in both nations. Do the cycles of science coverage coincide with long-term economic waves (see for example Bauer, 1998b)? Indeed, the years 1971–73 mark the end of the 'golden age of unparalleled prosperity' in Britain and elsewhere in the world (Maddison, 1998). This would suggest that economic factors might explain the tides of science news.

Alternatively, the public arena model (Hilgartner & Bosk, 1988) suggests limited capacity where some issues displace others in the daily news flow. What competed with science and technology for public attention during the 1960s through the 1970s? The economic crisis in the aftermath of the oil shocks of 1973 and 1978, the 'winter of discontent' of 1978–79, government instability in Britain, civil liberties in Northern Ireland, wars in Vietnam (ending in 1975) and in the Middle East (1967 and 1973) and Britain's retreat from Africa (Rhodesia/Zimbabwe) might have displaced science and technology news in the 1970s. This does not, however, explain why the decline in science coverage began during the mid-1960s. The 'white heat of technology' of the Labour Party programme of October 1963 had cooled already by the time of Labour's second election victory in 1966 (Childs, 1992: 175). The controversial pop culture of the 1960s – youth revolt, the Beatles, the Rolling Stones[17] and the student revolt of 1968 – may have competed with, or even challenged, the more sober science and technology news.

These speculations are necessarily ad hoc. As we pointed out, the present objective is to demarcate an *explanandum* rather than to provide the *explanans*. To explain these long-term patterns of science in public media coverage, the international comparison of similar data streams and the historical appreciation of the different contexts remain a challenge beyond this paper.

In the present study Britain and Bulgaria were focal as contexts of science news productions. But they can also be treated as proxy indicators of the scientific culture of the respective superpowers USA and USSR. This is more than an ironic remark on 'special relationships' – Britain as the '52nd state' to the West and Bulgaria as the '16th state' to the East. Both countries enjoyed close ties with their 'big brother', and in particular through their science and technology policies. This linkage is likely to be reflected in public attention to science from the 1950s through to the 1990s, and in the case of Britain even beyond. Furthermore, our results are possible *proxies* for the East and the West in general. One may want to work with this hypothesis until data of a similar scope are available from media in the USA, Russia or other specific contexts. Colleagues in Italy, the USA and in Brazil have recently started, or are considering, projects of similar ambition. These efforts may lead to globally comparable data of science news in the post World War II period.[18] Comparing data over this period will allow us to explain the coverage by means of co-variance analysis of context and content, and to test hypotheses regarding the forces that shape the long-term trends of science news. We hope that in the near future similar analyses of the former *PRAVDA* in the USSR or of the *New York Times* (or equivalent) in the USA will be available and thus contribute further to the comparative analysis of patterns of scientific culture. Agencies such as the National Science Foundation in the USA or relevant European Union ministries might consider media analysis as part of science indicators to assess public attitudes to science and technology and its changes.[19]

Notes

We thank the reviewers of an earlier version of the paper for helpful comments and suggestions. The project was supported by a grant (RSS/HESP no. 634/1995) from the Central European University (Soros Foundation) in Prague. Morag Brocklehurst of the London School of Economics helped with the English editing: highly appreciated when none of the authors is a native speaker.

1. There is an unfortunate tendency, even in social scientific circles, to equate public opinion with public opinion polls. This reflects the success of the polling industry, but amounts to what Habermas (1989 [1962]) rightly called the 'liquidation of public opinion'.
2. Frame analysis, defined strictly as an a posteriori statistical clustering of dramatic elements, must be the labour of another analysis. An a priori frame analysis is precluded in the present study, as we did not consider such an approach when developing the coding frame. The notion of drama might also suggest a comparative case study approach. Literary historians compare key dramas and thereby reveal formal innovations and topical preferences that characterize a period or a style. By contrast our approach is statistical. The number of 'news dramas of science' is, as it would appear, infinitely larger than the corpus of stage or film scripts in any language, and has

more a random element to it. This abundance of dramatic materials affords a statistical analysis to characterize context and time.

3. Members of the team were: Kristina Petkova, Tsocho Boyadjiev, Martin W. Bauer, Galin Gornev, Ivan Tchalakov and Diana Nenkova.
4. 'Tory' is the old name for the Conservative Party. The paper's political orientation has been consistently conservative and right of centre; however, the definition of what that means depends on the editor, proprietor and the ideology of the time.
5. In the period 1946 to 1996, the Conservative Party was the dominant political force in Britain. Of the 50 years, the Tories held office for 33 years from 1951 to 1964 (Churchill, Eden, Macmillan, Douglas-Home); from 1970 to 1974 (Heath); and from 1979 to 1996 (Thatcher, Major). The Labour party held office for 17 years, from 1945 to 1951 (Attlee), from 1964 to 1970 (Wilson), from 1974 to 1976 (Wilson) and 1976 to 1979 (Callaghan), the last in coalition with the Liberal Party (Childs, 1992). The Conservative Party considered itself the 'natural party of government' in 20th-century Britain. It is part of the current project of New Labour after 1996 to challenge this presumption of a traditional 'middle Britain' mentality.
6. 'Effective news space' is defined as the annual total print space minus the average advertising space. Total print space is defined as the average number of pages of the newspaper × 300 days (we are excluding Sunday editions). For each year we subtract the estimated average advertisement space reported by Seymore-Ure (1994), interpolated for years where such figures are not reported. This is a crude estimate of the space that could potentially be filled with news stories. We disregard the short-term fluctuations that have occurred in advertising, and we do not consider more precise definitions of news space, which might also exclude the various lifestyle and entertainment sections that emerged in the 1980s and 1990s. Obviously the correction of news space by subtracting advertising space is more relevant in Britain than in Bulgaria. Advertising is a feature of a market economy and much less prevalent in a command economy.
7. Most of our period fell into the pre-electronic age of the press. In the late 1990s quality newspapers started to make their copy available on CD-ROMs, online or via special information services, but initially backdated only into the 1980s. Hence, we had to work manually and with photocopies from microfiche archives. Under current conditions of generously backdated online archives, the sampling strategy for our project might look different. However, we are not clear how a generic category such as 'science and technology' could be implemented in a set of keywords for online retrieval. Online search facilities are perfect for specific issues, but problematic for the analysis of generic categories of coverage. For the latter, the coder–reader has clearly the advantage. The Media Monitor Archive, located at the London Science Museum Library, is a research resource open to researchers. It comprises more than 7000 press articles referring to science and technology over the period 1946 to 1992, systematically sampled from the range of British quality and popular newspapers. The data are accessible in hard copy and in coded format, as SPSS data files. Interested researchers should contact the principal author: M.Bauer@lse.ac.uk.
8. British data are biannual. To compare coverage, we pooled consecutive years in Bulgaria: 1946–47 = 1946; 1948–49 = 1948, and so on.
9. Compared with percentage of agreement, coefficient kappa is a conservative measure. It weights the percentage of agreement against the expected random agreement among the coders.
10. The validity of a single newspaper proxy depends on the context and the aggregation of time. The single proxy is more valid in a competitive newspaper market than in a market that is clearly split and monopolized in each segment, and it depends on the time intervals considered. Coverage that diverges on a weekly or monthly basis might well correlate annually. In measuring salience of science news over time, we have good evidence that quality and popular newspapers follow a similar annual pattern in the UK, albeit not with the same volume (Bauer, 2000b). On biotechnology, the volumes of coverage of quality newspapers correlate highly in Britain, not least because national

newspapers are operating under cut-throat competition in overlapping market segments. On general social and political issues, Woolley (2000) advises caution based on US data. Local and national newspapers are windows to different worlds, and so-called national newspapers might still reflect regional agendas; this does however not apply to Britain, where all national papers are London-based. On the evaluation and the framing of issues, the assumption of a single newspaper proxy might be more problematic. Historical studies show that the divergence and convergence in newspaper coverage is an indicator of national crisis (for example, Imhof et al., 1993): in quiet times different newspapers go their own ways. Hence the presumption of a single proxy is valid for the salience of science and technology in British public opinion. While in evaluation and framing a single proxy might not be representative of the spectrum of public opinion, but represent a particular and dominant political milieu as in the case of the *Daily Telegraph*.

11. For these calculations we consider the following:
Britain (1946–92): a sample of 10 random weekdays for 23 years, every second year since 1946, yields 2832 articles. The total number of articles is estimated: $2832 \times 300 \times 46 / 23 \times 10 = 169920 \pm 10\%$. 300 days over 46 years (1946–92), with an average of 28 pages per issue of which on average 45% is advertising, yields $300 \times 46 \times 28 \times (1–0.45) = 212{,}520$ pages of effective news space. Comparing space and articles we estimate that on about every second (ratio 1.1–1.4:1) page there is a reference to science and technology.
Bulgaria (1946–95): the total of articles is 5841 over the entire period. The effective news space is as follows: 300 days over 49 years (1946–95) and an average of six pages per issue with little or no advertising. This yields $300 \times 49 \times 6 \times (1–0) = 88{,}200$ pages of news space. Comparing space and articles we find that in Bulgaria about every 15 pages (ratio 15:1) there is a scientific and technological reference.
Conclusion: Overall, in Britain science and technology had 10 to 14 times more coverage than in Bulgaria over the period 1946–95, relative to the annual news space in any year.
12. While this study does not cover the period after 1992 in Britain, evidence from unpublished materials suggests that science coverage continued to increase through the 1990s. For genetic engineering and biotechnology alone, we counted 1600 references in one single newspaper source in 1999; contributing four to five references per day on this issue alone (Bauer et al., 2001).
13. With a view to constructing cultural indicators, this diversification is validated by surveys of science literacy: popular knowledge increasingly specializes in either the biological or the physical sciences, thus displacing a one-dimensional structure of science literacy. This phenomenon might be a characteristic of the 'post-industrial mode' of public understanding of science (Bauer et al., 1994; Durant et al., 2000).
14. An earlier analysis demonstrated the 'medicalization of science news' in Britain. In the popular press biomedical news comes to dominate science coverage already from the mid-1970s onwards (Bauer, 1998a).
15. The high intercorrelation between the indicators – risk, benefit and promise – suggests a convergent validity in the assessment of evaluation. The imperfect correlation between the three indicators suggests that these measures complement each other in measuring 'evaluation'.
16. It might be that the news value 'controversy' gains importance only in later years, which are the years less celebratory of science than the 1950s and 1960s. A correlation over the whole period masks such changes. Furthermore, some topics may be controversial while others are not. There is no synchronization of controversy in Britain and in Bulgaria. The flow of scientific and technological controversy in the two contexts is clearly a topic for further analysis.
17. The Beatles and the Rolling Stones, the icons of British culture of the 1960s, made various headlines after 1967 through moral panics about their taking drugs and their 'hedonistic and irresponsible behaviour' displayed in public, a lifestyle also labelled as 'Generation X'.

18. A comparative database is clearly a necessity for cumulative knowledge in this kind of research. We can only hope that other researchers consider the present coding effort and refrain from reinventing the wheel. The procedure to adopt can be modelled on survey research: some variables are unchanged to support time series analysis and comparison, others are adjusted to fit the specific context of the researcher, and new variables are developed to innovate. This will ensure comparability as well as innovation in international analysis of science coverage. The methodology of content analysis historically suffered much from a cottage industry mentality, working in splendid isolation and reinventing the wheel with every project. It is time to think 'bigger' and to raise the ambitions.
19. It is likely that a combination of surveys of public perceptions and of mass media coverage of science and technology will be more cost-effective for the construction of indicators of public attitude to science and technology than the traditional survey of perceptions alone. The period between surveys of perceptions could be extended, and the years between surveys could be monitored by far cheaper mass media analysis.

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Appendix

TABLE 1
The samples and the estimated total science coverage, 1946–95

Country	Britain	Bulgaria
Newspaper	The *Daily Telegraph* 1946–92 (46 years)	*Rabotnichesko Delo* (*Duma* after 1990) 1946–95 (49 years)
Database as coded	Biannual, every 2nd year; 10 random weekdays per year; *N* 2832	Annual, no sampling, complete, every issue; *N* 5841
Total coverage	*n* 169920 (±10%); *n* per year 3670 (±10%); 60–78 per week; 10–13 references per d	*n* 5841; *n* per year 119; 2–3 articles per week; < 1 article per d

Notes: See note 9.

TABLE 2
The coding frame

Country [nation]	Bulgaria [= 1] Britain [= 2]
Date of article [nyear]	Year of publication; Basis to calculate intensity figures for each year.
Pages per issue [totpage]	The total number of pages of the paper issue that contained the article; used to estimate the effective news space.
Scientific event [q36]	The coding of the scientific discipline used in the listing in *Encyclopaedia Britannica* (1992). These were then further grouped as: (1) social sciences; (2) physical sciences; and (3) biomedical sciences.
Big topics [q37]	A number of 'big science' activities: nuclear power, biotechnology, information technology, space exploration, environment, AIDS.
Controversy index [q15]	Reportage refers to controversy; Annual index = 100(yes contro – no contro)/total; [–100 to +100] High value = controversial reporting
Evaluation tone [eval18]	Evaluative tone of the material, measured as 6-point rating: 1 = discourse of great promise; 6 = discourse of great concern; [DK included = 3]
Benefit/risk index benefits [q48] risk [q53]	Consequences of the scientific event: mentions benefits and/or risks; Annual index = 100(%benefit–%risk)/total; [–100 to +100] High value = discourse of benefits
Enthusiasm index Optimism [q19d] Advocacy [q19b]	Sum of semantic differential 'pessimism–optimism'; 'critical-advocating' on 7-point scales; excluding DKs. Mean values; High value = enthusiasm

TABLE 2
Continued

Mobilization index [q58]	'Moral of the story': support or resistance Annual index = 100(yesmob–nomob)/total; [–100 to +100] High value = mobilization

Notes: DK, do not know (the coder could not decide whether the articles presented a 'discourse of promise' or a 'discourse of concern'. The variables names' as used in the database are shown in square brackets.

TABLE 3
Basic results and analysis of variance (ANOVA) model

		Britain	Bulgaria	ANOVA
Indicator	Definition	(1) average (2) Eta (year)	(a) average (b) Eta (year)	Interaction effect (Eta^2)
Intensity *N* 8672	Articles per year	*N* 3670 +/– (estimate)	*N* 119 (count)	0.05
	(Relative to editorial space)	One science article for every two news pages	One science article for every 15 news pages	Ratio 10:1
Controversy	Annual index	(1) – 55	(a) –85	
		more controversy	less controversy	0.03
	High = controversial	(2) 0.25	(b) 0.25	
Risk/benefit	Annual index	(1) +11	(a) +39	
	High value =	more risks	less risks	Benefit: 0.04
	benefits	(2) 0.30	(b) 0.24	Risk: 0.03
Enthusiasm	Mean of ratings	(1) 4.13	(a) 5.53	
	High value =	less enthusiastc	more enthusiastic	0.05
	enthusiasm	(2) 0.17	(b) 0.38	
Evaluation	Mean of ratings	(1) 2.47	(a) 3.52	
		more negative	more positive	0.05
	High = promising	(2) 0.17	(b) 0.40	
Mobilization	Annual index	(1) –62	(a) +28	
		little mobilizing	more mobilizing	0.01
	High = mobilization	(2) 0.16	(b) 0.20	

Notes: ANOVA tests the linear model with two factors and interaction effect: Y = f (nation, year, nation × year). For all variables, the country effects are stronger than the year effects. 'Eta' measures the linear year effect. The interaction effect (eta^2) measures how much the linear trend differs in Bulgaria and Britain. All values are statistically significant, $p < .01$.